Potential Consequences of Climate Mitigation for Land Use Change in the 21st Century

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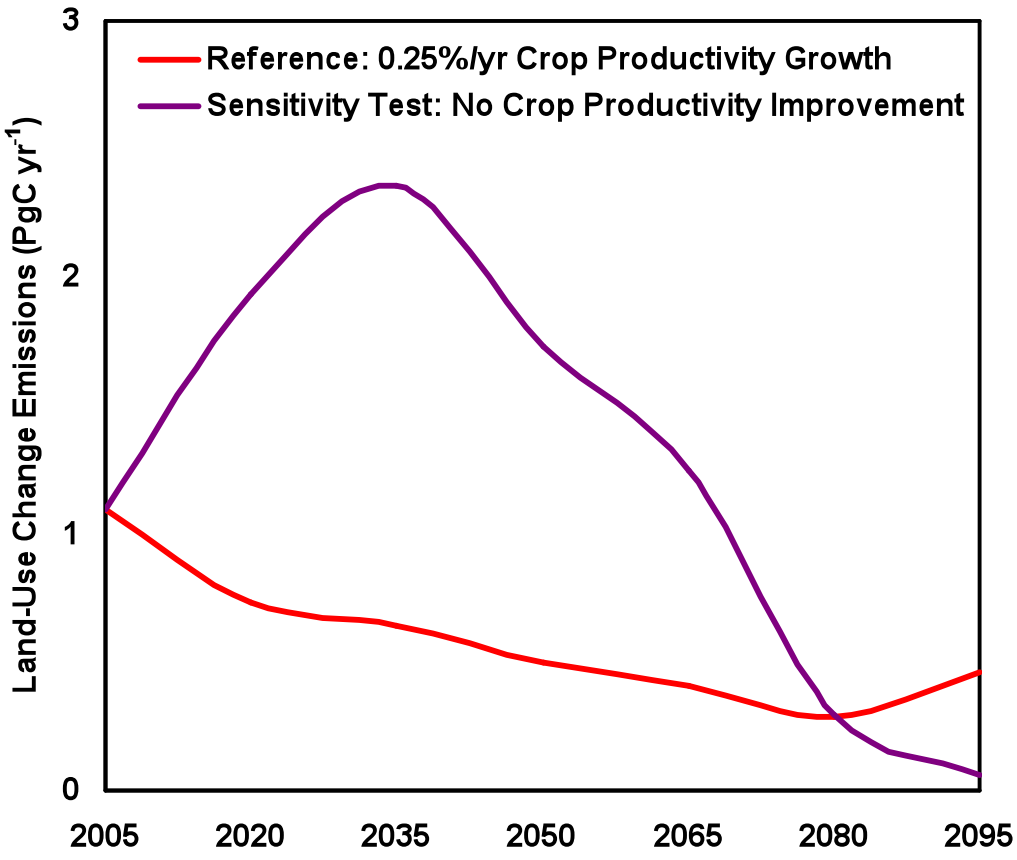
Overview

- Typical disciplinary split allows for studies of
  - Mitigation (e.g. biofuels, soil C sequestration), assuming plants not impacted by climate change and resources not diverted for adaptation
  - Adaptation (e.g. changing crop management), assuming land resources are not affected by mitigation
- Both assumptions are false, but sometimes necessary to simplify individual studies.
- Can global models provide insights into the significance of these assumptions?
- Here we test a land use factor of interest for both migitation and adaptation - **agricultural productivity growth** - in a simulated global mitigation policy.

Crop productivity and land use

- Crop yields are expected to continue to increase over time (FAO), however this is:
  - Uncertain, and also
  - Sensitive to the impacts of climate change
- Improving agricultural crop productivity reduces deforestation pressure.
  - Cumulative land-use change emissions 2005 to 2095: **72 PgC.**



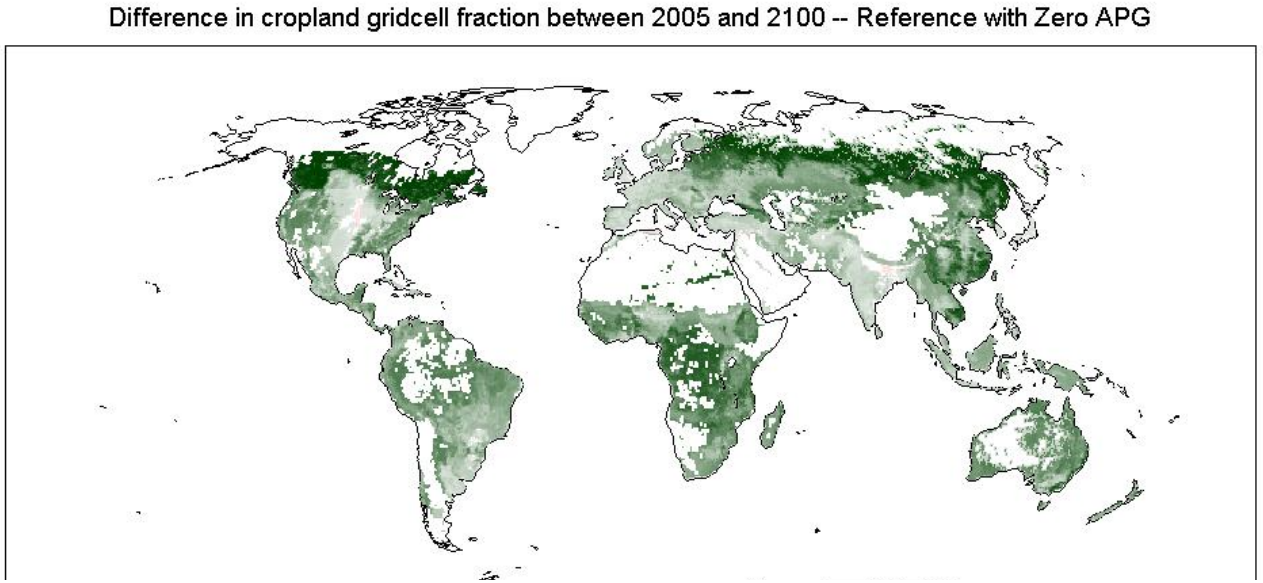
GCAM simulations with no mitigation

Scenario design

- Apply the GCAM model used in emissions scenario simulation and analysis of mitigation policies.
  - Considers future growth in population and income, and future transformations in energy technology
  - No climate impacts are simulated
  - Land use simulated at the global scale for 14 regions and downscaled to a grid
- Mitigation policy discussed here is the RCP4.5 stabilization case:
  - ~650 ppm CO_2-e in 2100
  - Emissions price applies equally to emissions from land use as well as emissions from energy and industrial processes.
- Simulations conducted with two set of exogneous parameters on agricultural productivity growth (APG)
  - Standard: Follows FAO to 2030 and converges to 0.25%/year
  - zAPG: Held constant at 2005 yields

Change in crop and forest land from 2005 to 2100 when agricultural productivity DOES NOT increase

Reference Case (zAPG)



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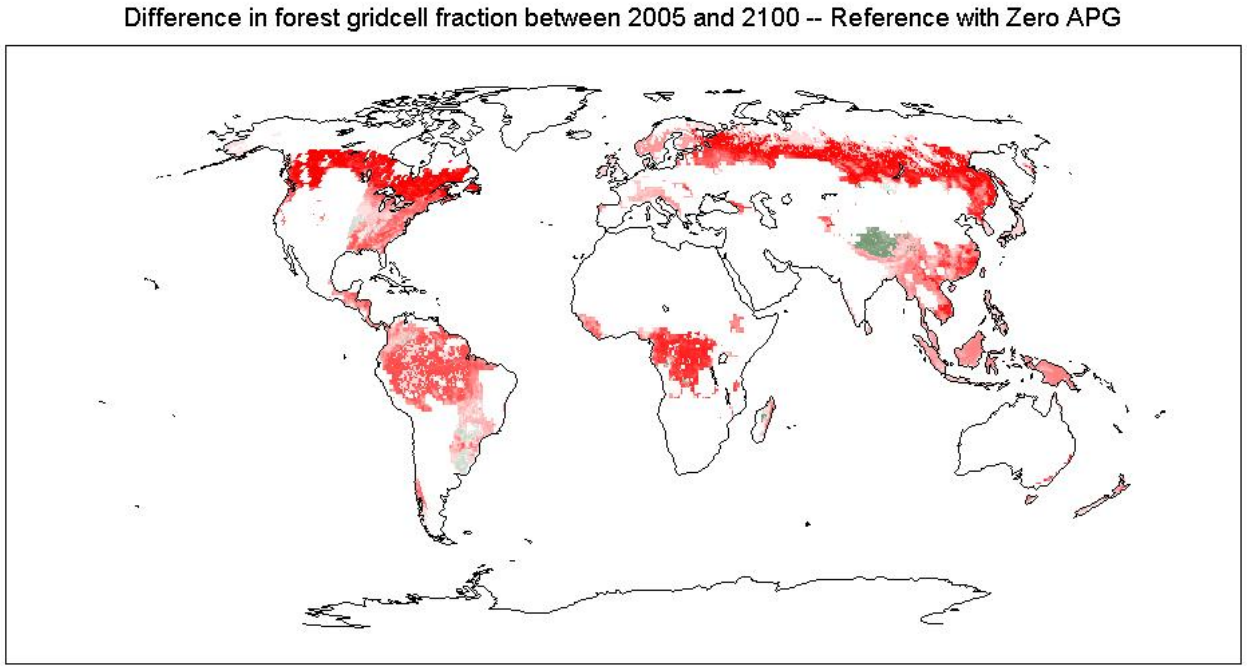
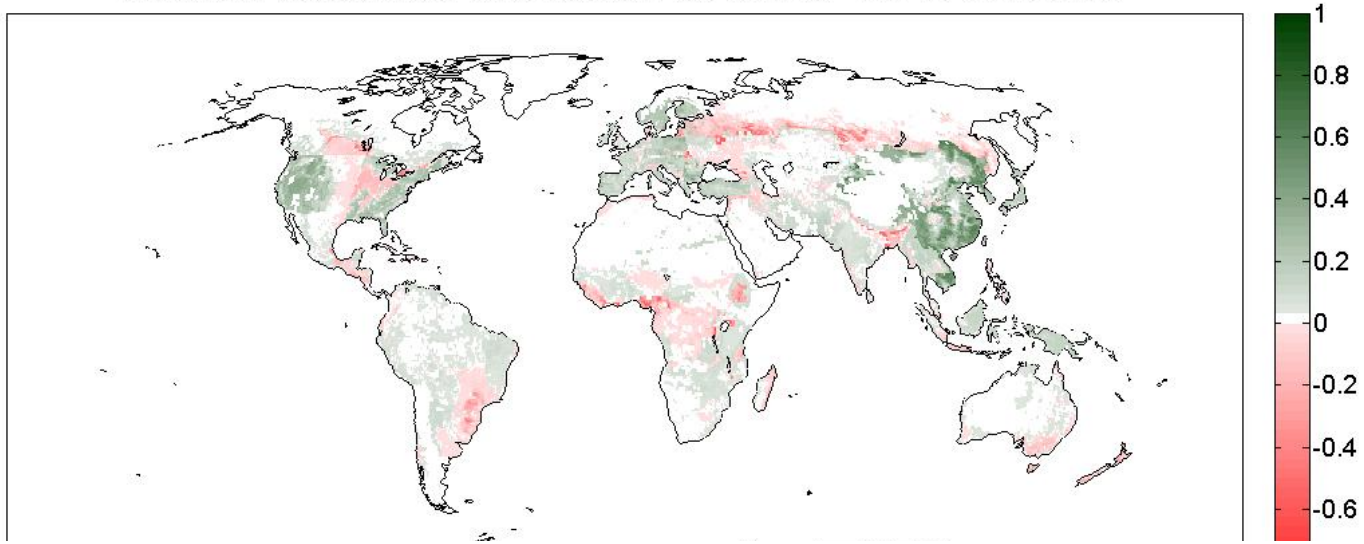


Forest

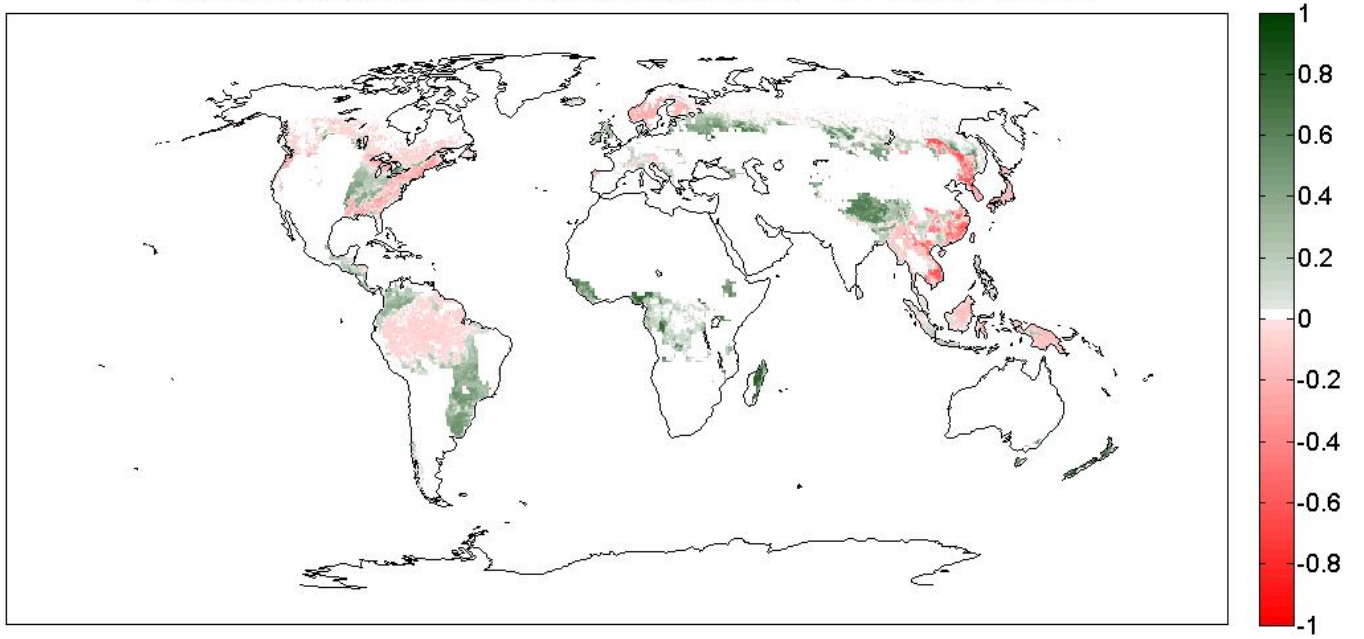
Climate Mitigation Scenario (zAPG)

Difference in cropland gridcell fraction between 2005 and 2100 -- RCP4.5 with Zero APG



Cropland

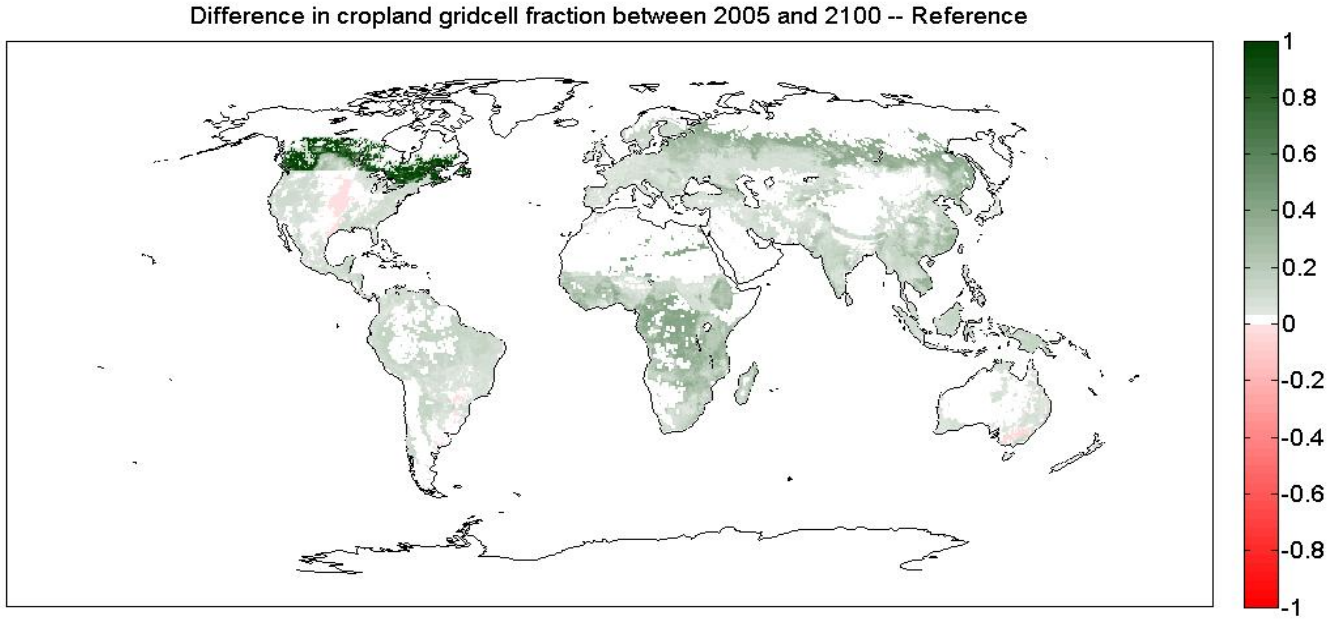
Difference in forest gridcell fraction between 2005 and 2100 -- RCP4.5 with Zero APG



Forest

Change in crop and forest land from 2005 to 2100 when agricultural productivity DOES increase

Reference Case



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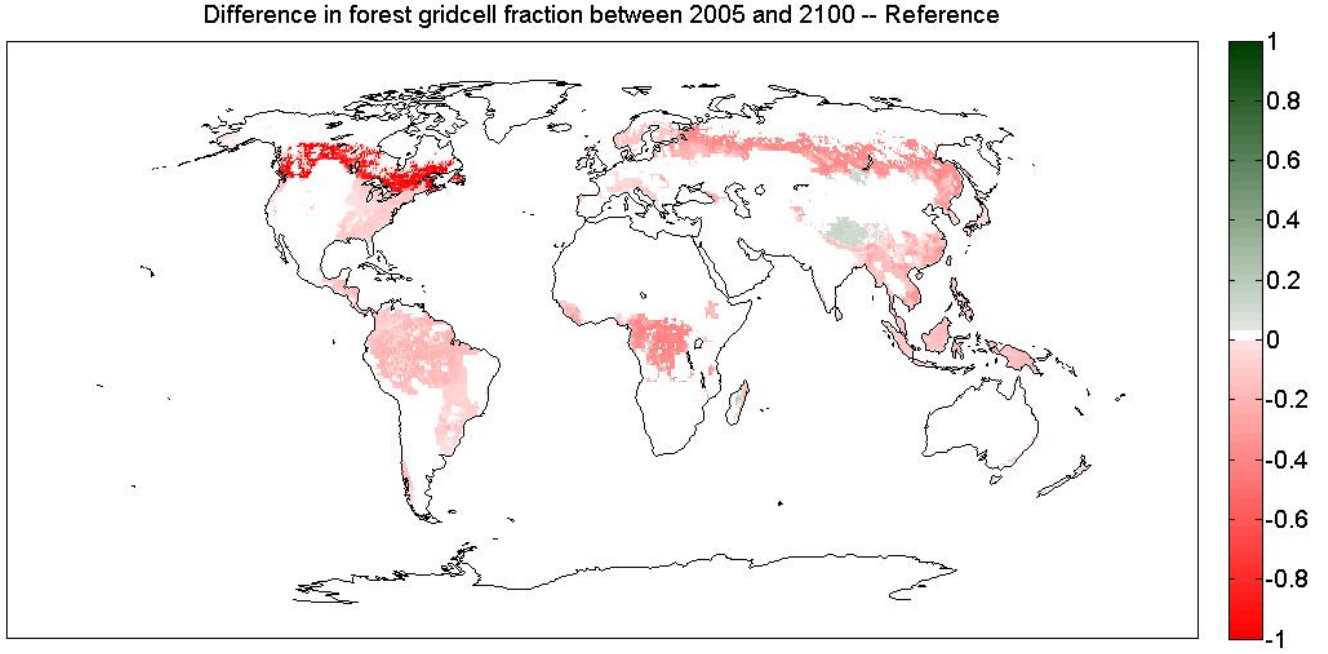
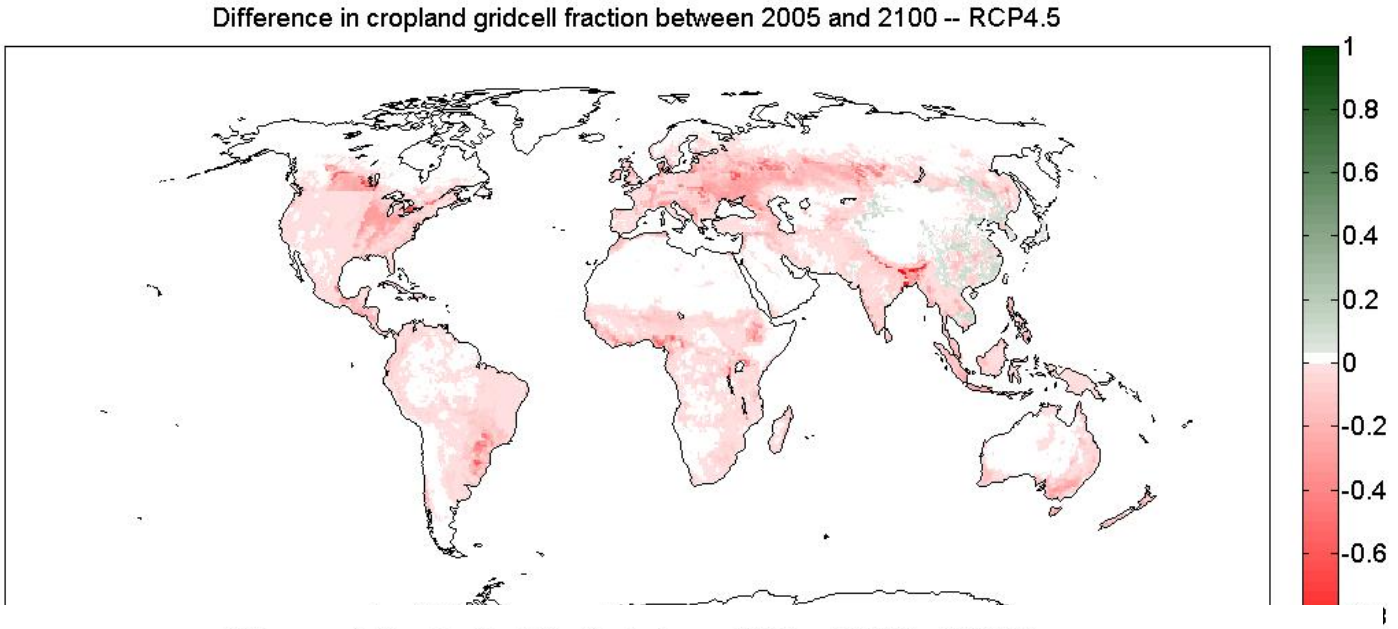


Forest

Climate Mitigation Scenario (RCP4.5)



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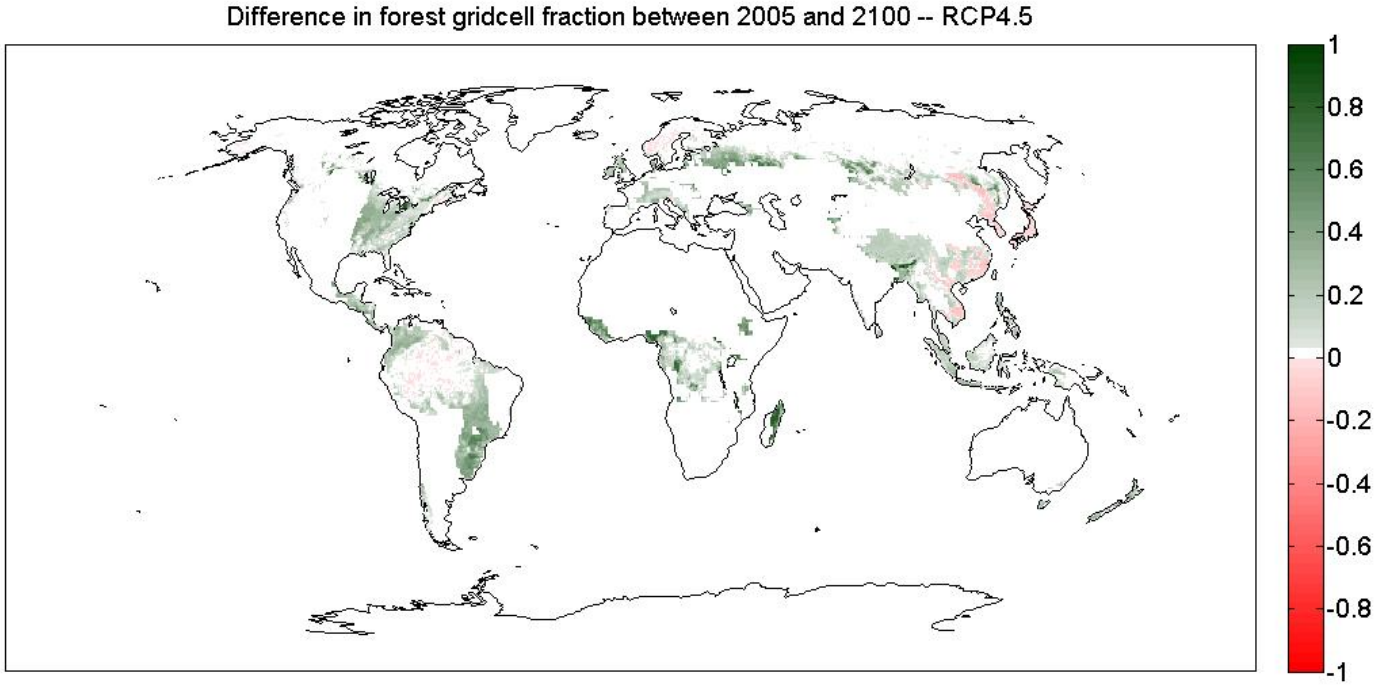
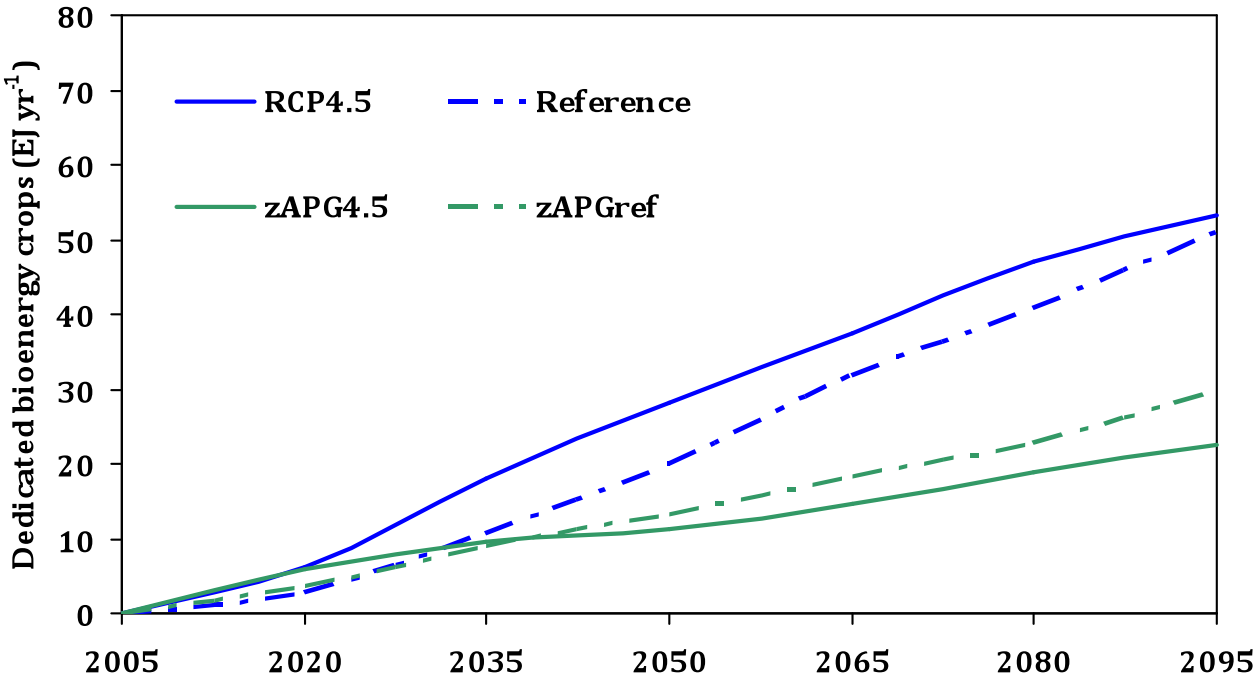


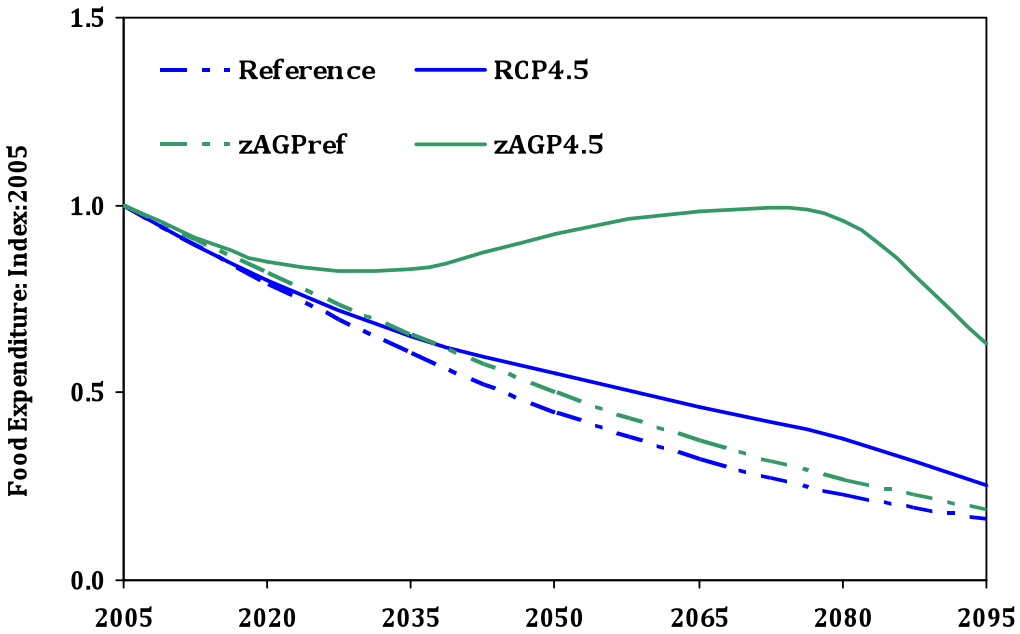
Forest

Bioenergy Supply – mitigation indicator



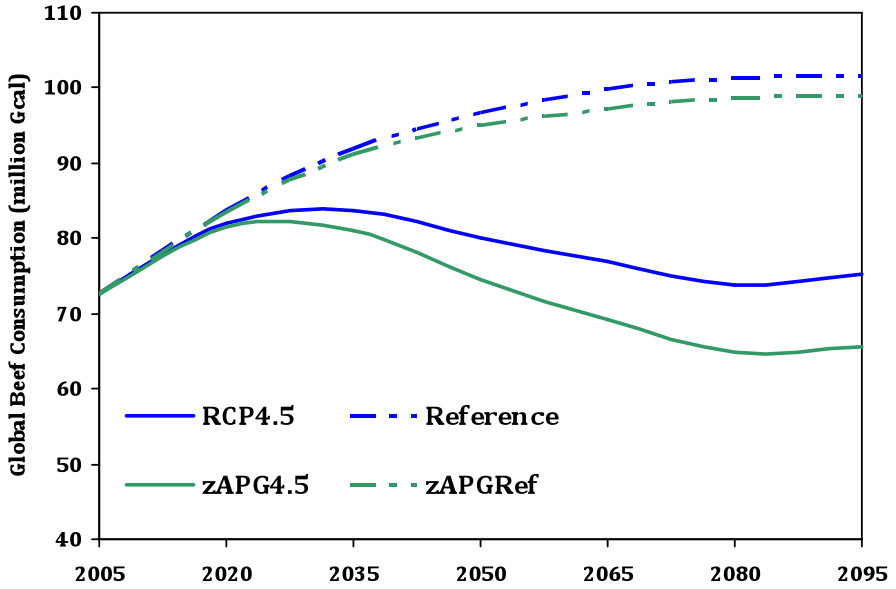
- Mitigation preference for forested land results in less bioenergy crop production than a corresponding *reference* case.
  - Causes higher prices in the energy sector and makes mitigation policies more difficult

Food Supply – adaptation indicator



Cost of food produciton increases Food expenditure (as a fraction of income) declines.

Terrestrial C policies encourage a shift away from beef consumption; lower APG has a similar, although smaller, influence.



Findings

- Potential land use change associated with mitigation is large and an important consideration in adaptation planning.
- Pressure to expand crop land is greater when
  - Agricultural crop productivity does not increase
  - No terrestrial C valuation policy is in place.
- Agricultural productivity improvements can be seen as **both** an **adaptation** and **mitigation** priority.
  - Keep the cost of food production low
  - Make land available for bioenergy and reforestation

Questions?